Consequences of Violation of Frozen-in Flux at the end of Substorm Growth Phase

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To investigate the consequences of a localized violation of frozen-in flux in the plasma sheet at the end of a substorm growth phase, we carried out a simulation with the Rice Convection Model Equilibrium (RCM-E) model, which consists of the RCM model coupled to an equilibrium magnetic field. We started with an RCM-E-computed growth-phase magnetic field that is highly stretched in the inner plasma sheet and has a large region of nearly uniform entropy parameter. Violation of frozen-in flux implies that magnetic field lines slip on the plasma, creating a plasma bubble (region of reduced entropy parameter) just earthward of the disruption. A plasma blob (region of increased entropy) appears on the tailward side. To represent this in the model, we imposed a bubble and blob on the RCM-E growth-phase configuration, with the result shown in Figure 1a. Then we followed the subsequent evolution. The bubble surges earthward and blob moves tailward, as indicated by the configuration shown in Figure 1b, which is for a later time. As a consequence, the z-component of the magnetic field between the bubble and blob decreases dramatically, as shown in Figure 2b, and the current sheet thins. We speculate that, in the real system, the positive feedback would thin the current sheet more and more until reconnection occurs. These results were presented at the ICS-10 workshop in March 2010. A paper entitled: "Simulation of a bubble-blob pair in the near-Earth plasma sheet" by J. Yang, R.A. Wolf and F. R. Toffoletto has been submitted to GRL.

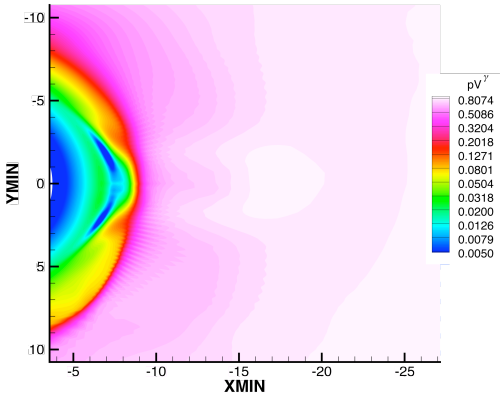

Figure 1a: Initial disturbance of $pV^{5/3}$ at the end of the growth phase.

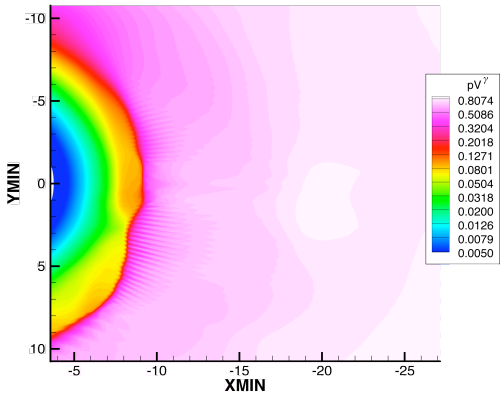

Figure 1b: Subsequent motion of bubble/blob pair, the blob moves tailward with the bubble is injected into the inner magnetosphere.

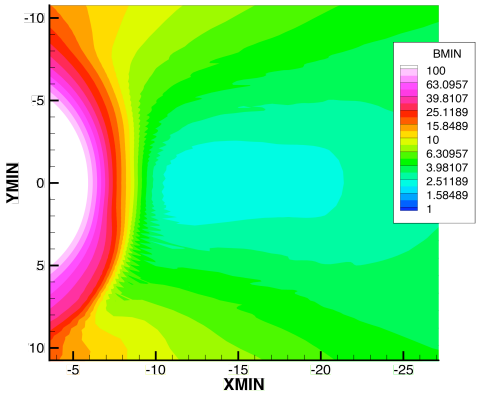

Figure 2a: Initial configuration of of the z-component of the magnetic field, along the equatorial plane after the end of the growth phase.

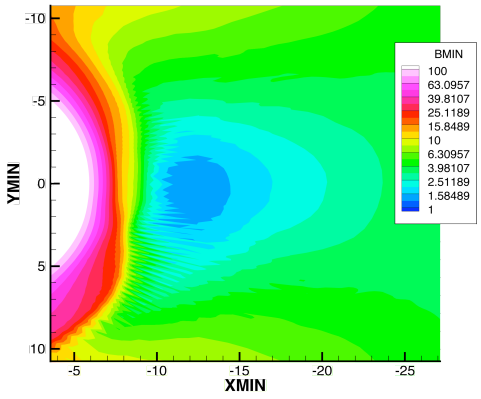

Figure 2b: Evolution of the z-component of the magnetic field, along along the equatorial plane as the bubble/blob pair moves.